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IS : 7415 - 1974

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Indian Standard

CODE OF SAFETY FOR ANILINE

(First Reprint JANUARY 1984)

UDC 547·551·1 : 614·878

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6

April 1975

Indian Standard

CODE OF SAFETY FOR ANILINE

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(*Continued on page* 21)

Indian Standard

CODE OF SAFETY FOR ANILINE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 July 1974, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 Aniline is an important organic chemical used in the manufacture of dyes, medicines, resins, varnishes, perfumes, shoe polishes, etc, in vulcanizing rubber and as a solvent. It is highly toxic and is flammable. Intoxication may occur from inhalation, ingestion or by absorption through direct skin contact. The most common modes of accidental poisoning are spillage of the liquid on the skin or clothing leading to direct skin contact or the prolonged inhalation of vapour under circumstances of inadequate ventilation. The threshold limit in air by volume is 5 ppm, but the odour of aniline can usually be detected in concentrations of 0·5 ppm, thus providing a good warning margin. Observance of this code of safety will reduce the frequency of hazard.

0.3 Aniline is chemically also known as amino benzene or phenyl amine. Commercially it is known as aniline oil because of its oily appearance.

0.4 The properties of aniline listed under **3** have been taken from literature and have been included for information only. Moreover, these properties pertain to the pure aniline. However, for technical aniline, IS : 2833-1964* has been published.

0.5 In the preparation of this code, considerable assistance has been derived from 'Safety Data Sheet No. SD-17 Aniline', issued by Manufacturing Chemists' Association, USA.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off values should be the same as that of the specified value in this standard.

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*Specification for aniline, technical.

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard describes the properties of aniline, the nature of hazards associated with it and essential information on storage, handling, packing, labelling, disposal of waste, cleaning and repair of containers, selection and training of personnel, personal protective equipment and first-aid.

1.1.1 This code does not deal with specification for design of buildings, chemical engineering plants, storage vessels, equipment for operations control and waste disposal.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 4155-1966* and IS : 4167-1966† shall apply.

3. PROPERTIES OF ANILINE

3.1 The important properties of aniline are as follows:

a) *Physical State*	Transparent oily liquid
b) *Colour*	Colourless to pale yellow when freshly distilled, darkens on storage
c) *Odour*	Characteristic amine odour
d) *Relative Density*	1·018 to 1·019 at 27°C/27°C; 1·022 at 20°C/4°C
e) *Crystallizing Point*	6·4°C
f) *Boiling Point*	184·2°C at 760 mm
g) *Flash Point*:	
Open cup	75·6°C
Closed cup	75·0°C
h) *Auto Ignition Temperature*	70°C
j) *Flammability*	Flammable
k) *Explosive Limits* (Percent by volume in air)	Lower limit — 1·3 Upper limit — 19
m) *Corrosivity*	None
n) *Light Sensitivity*	Tends to darken on exposure to air and light
p) *Vapour Density* (air = 1)	3·22

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*Glossary of terms relating to chemical and radiation hazards and hazardous chemicals.

†Glossary of terms relating to air pollution.

q) *Solubility*

Soluble in any ratio in ethyl alcohol, ethyl ether and benzene

Soluble in most of other organic solvents

Solubility in water is as follows:

Temperature (°C)	*Aniline in Water, Percent*	*Water in Aniline, Percent*
25	3·5	5·0
90	6·4	9·9

r) *Hygroscopicity* Not hygroscopic

s) *Refractive Index* 1·586 3 at 20°C

4. HAZARDS ASSOCIATED WITH ANILINE

4.1 Health Hazards

4.1.1 *General* — Since aniline is soluble in fat, it is easily absorbed through skin. If it penetrates into blood through skin or inhalation of its vapour, man suffers from acute or chronic toxicosis. It is rather a rare case that the operators in a plant absorb aniline through mucous membranes of digestive organs. However, they may present the toxic symptoms if they smoke or eat with their fingers or use table wares which are contaminated with aniline.

4.1.1.1 The intake of 10 g of aniline causes a strong toxic symptom. The fatal dose of aniline is 0·5 g/kg for a warm-blooded animal.

4.1.2 *Acute Toxicity*

4.1.2.1 *Systemic effects* — Aniline causes the conversion of hemoglobin to methemoglobin. The latter compound cannot release the oxygen necessary for adequate body metabolism. The evidences of poisoning are secondary to the resultant loss of oxygen carrying capacity of the blood.

4.1.2.2 The clinical picture of aniline poisoning varies with the intensity of the exposure. Moderate exposure to aniline may cause only a bluish discoloration (cyanosis) of the cheeks, lips, ears, finger nail beds, etc, with no subjective symptoms; however, there may be a temporary sense of well being or exhilaration due to the slight decrease of oxygen in the blood. As the oxygen deficiency increases because of the formation of more methemoglobin, the cyanosis may be associated with headache, weakness and irritability. In more severe exposures, headache, palpitation, dizziness, drowsiness and shortness of breath are often present; eventually the patient may become unconscious and collapse. If treatment is not rendered promptly, death can occur.

4.1.2.3 *Local effects* — Aniline is mildly irritating to the eyes and may cause corneal damage. Therefore, following a splash, the eyes should be flooded with copious amounts of water for at least 15 minutes holding the eyelids apart, if necessary. It is advisable for a physician to see all such cases.

4.1.3 *Chronic Toxicity*

4.1.3.1 *Systemic effects* — Repeated skin or respiratory exposure to low concentrations of aniline may produce headache, irritability, dizziness, insomnia, decreased appetite, pallor and low grade secondary anaemia. The blood may contain methemoglobin, the red cells may show Heinz bodies and aminophenol may be present in the urine. All clinical and laboratory manifestations disappear with no permanent residual pathology demonstrable upon complete cessation of exposure.

4.1.4 *Symptoms from Inhalation of Aniline Vapour*

Concentration of Aniline in the Air		*Symptoms*
mg/l	ppm	
0·03-0·1	7-26	Light symptom appears, in case the vapour is inhaled for a long time
0·15-0·2	40-53	No symptom is recognized in 6 hours
0·4-0·6	105-160	The maximum concentration at which man can breathe for an hour without trouble

4.1.5 *Threshold Limit Value (TLV*) in Air* — The upper limit of aniline vapour concentration considered safe for continuous exposure for 7-8 hours work day and 40 hours work week is 5 ppm or 19 mg/m^3 in air.

4.1.6 *Local Effects* — Man may suffer from local eruption and hyperemia of the conjunctiva, when his skin is exposed to aniline.

4.2 Fire and Explosion Hazards

4.2.1 At normal temperature, aniline is slightly volatile and there is no danger of explosion.

4.2.2 Aniline is a flammable liquid, having the ignition point of 76°C. When aniline is heated to decomposition temperature, it emits highly toxic fumes. In case aniline is heated at somewhat higher than its ignition point, it becomes as dangerous as gasoline at normal temperature. Consequently, full attention should be paid for handling aniline under such conditions. Such mass of air that contains more than 1·8 percent of the vapour can be exploded at a temperature higher than the said ignition point.

4.2.3 The relative density of aniline is 1·018 at 27°C which is greater than that of water. Since, however, the former becomes less than the latter in the vicinity of 100°C, aniline floats on the surface of water and the mixture becomes very flammable.

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*As accepted by American Conference of Governmental Industrial Hygienists.

4.2.4 Once aniline contacts fuming nitric acid or concentrated nitric acid, it reacts fiercely and catches fire.

5. STORAGE AND HANDLING

5.1 Building Design — Not less than two means of escape should be provided for each separate room or building in which aniline is stored, handled or used. All exit doors should open out in the direction of travel and should be provided with panic hardware.

5.2 Equipment Design

5.2.1 *Storage* — Aniline is commonly stored in a mild steel tank (*see* IS : 2552-1970*).

5.2.2 *System Types* — A closed type system shall be used in handling aniline. In open or partially open systems, care shall be taken to prevent the escape of vapours into areas where the toxic properties might be a hazard to personnel. Vents equipped with flame arresters (flash screens) are necessary for aniline storage tanks if the tank contents are heated or the tank is so located that it may be exposed to fire, heat or sun.

5.3 Ventilation — Good ventilation is essential in storage rooms or area where aniline is handled to prevent the accumulation of toxic vapours which have a comparatively low threshold limit in air. Aniline vapour is 3·22 times heavier than air, and its removal requires consideration of such factors as dead air spaces, temperature, air currents, wind directions, etc. Mechanical ventilation should be provided at the most likely points of origin and area ventilation intakes should be located close to floor level. All ventilating systems require periodic inspection. Under abnormal conditions, such as spills or leaks, all available ventilation should be used.

5.4 Electrical Equipment — All wiring and equipment should be installed in flameproof enclosures as per IS : 2148-1968†. In situations where material is handled at temperatures near or in excess of its flash point temperature, wiring and equipment should be as per requirements of the above mentioned standard.

5.5 Precautions During Transportation

5.5.1 When aniline is transported, refrain from transporting it together with other materials, particularly oxidizing materials. This, however, is not applied in case only a small amount of aniline is transported or there exists no possibility of causing any accident.

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*Specification for steel drums (galvanized and ungalvanized) (*first revision*).

†Specification for flameproof enclosures for electrical apparatus (*first revision*).

5.5.2 Sufficient care shall be taken during the transportation not to drop the containers and cause accident.

5.5.3 During the transportation, put a sign in a prominent place indicating the existence of hazardous material.

5.5.4 Cover the container with appropriate materials in order to intercept sunlight.

5.5.5 Be sure that there is no fire nearby when aniline is unloaded. No smoking is allowed.

5.5.6 Check whether or not there is any leakage at every delivery. If any leak is found, take sufficient care during handling of aniline and place the leaking container in such a way that the leaking part comes to the top and transfer such a container to a safe place and stop the leakage or replace the defective one with a new container which has no leak.

5.5.7 Before the container for delivery is loaded or unloaded, it shall be sufficiently earthed also as to prevent any sparking.

5.5.8 Open the main way before taking the metallic cap away at the unloading point so as to release the pressure inside the cart.

5.6 Precautions During Storage

5.6.1 Install a lightning conductor on the tank and the store house.

5.6.2 Keep them away from fire, gas burners, furnaces, welding devices and any other installations which may cause spark.

5.6.3 Post the signs of 'Danger' and 'No smoking' at the tank and the store house.

5.6.4 Earth every tank to prevent static electricity from accumulating.

5.6.5 Every tank shall be tightly sealed and have a vent pipe whose outlet faces outdoors. Provide each tank with a flame arrester.

5.6.6 Build a dike around a large field storage to keep the liquid from flowing out beyond the dike in case the tank is broken.

5.6.7 Inspect every tank of aniline periodically, and keep it under safe conditions.

5.7 Precautions During Use

5.7.1 Since drums are not pressure containers, do not use any compressed air or gas to transfer aniline from the drums.

5.7.2 Wear rubber aprons, head wear, rubber gloves, and goggles/face shields. In case aniline smell is quite strong, wear appropriate respiratory protection.

5.8 Spills and Leakages

5.8.1 Inspect frequently the equipment in order to check if any leak takes place and to prevent its occurrence.

5.8.2 In case aniline is spilt over the floor, wash it away with a sufficiently large quantity of cold water, and soap or detergent until its odour disappears. In case cool water is not available, use dry sand to absorb aniline.

5.8.3 In case aniline is found to leak out of a container, transfer such a container to outdoors or to a well ventilated place, and transfer aniline into another container.

6. AIR ANALYSIS

6.1 Analysis of the air for aniline in the work area will give a measure of the effectiveness of engineering control of the vapour. It may be performed to detect leakage of aniline vapours from equipment and also to ascertain the order of magnitude of the health and fire hazard existing in the work area. It should be kept firmly in mind that the use of these instruments and test procedures for the detection of aniline in the air requires specially trained personnel.

7. PACKING AND LABELLING

7.1 Packing

7.1.1 The material shall be packed in suitable drums conforming to IS : 2552-1970*.

7.1.2 Each container shall be securely closed and shall bear legibly and indelibly the following informations:

a) Name of the material,
b) Name of the manufacturer,
c) Lot or batch number,
d) Tare net and gross mass, and
e) The word 'Poison' [red label printed on white background conforming to Fig. 1 of IS : 1260 (Part I)-1973†].

7.1.3 Each container shall, in addition, bear minimum cautionary notice worded as under:

> 'KEEP WELL CLOSED AND PROTECTED FROM HEAT AND LIGHT; TOXIC, AVOID CONTACT WITH SKIN.'

7.2 Labelling

7.2.1 *Labelling and Placarding*

7.2.1.1 Each container (including tank cars) should carry an identifying label or stencil.

7.2.1.2 Each shipping container shall bear the POISON label (red printing on white background).

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*Specification for steel drums (galvanized and ungalvanized) (*first revision*).

†Pictorial markings for handling and labelling of goods: Part I Dangerous goods.

7.2.1.3 Each returnable drum used for aniline shipment shall bear special bung label.

7.2.1.4 Each tank car and each rail road car carrying one or more containers of aniline shall bear 'DANGEROUS' placards.

7.2.1.5 The containers before disposal should be rendered harmless by the user (*see* **8.1.4**).

7.2.2 *Other Precautionary Labels* — The following label text is designed for the product as shipped for industrial use. It is recommended in addition to or in combination with any label warning or other statements required by statutes, regulations, or ordinances. The labelling requirements as per statutory regulations should be observed for containers destined for household use.

ANILINE

DANGER ! POISON ! EXTREMELY HAZARDOUS !
LIQUID AND VAPOUR RAPIDLY ABSORBED
THROUGH SKIN

Avoid spillage or leakage.
Do not get in eyes, on skin, on clothing.
Avoid breathing vapour.
Handle only with adequate ventilation.
In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin or eyes with plenty of water for at least 15 minutes; get medical attention.
Wash clothing before re-use.

8. PREVENTIVE MEASURES

8.1 Personal Hygiene

8.1.1 Aniline is easily absorbed in human body through skin or respiratory organs, improve the equipment and operation methods lest aniline should leak or its vapour should transpire.

8.1.1.1 The operations should be carried out in the perfectly closed equipment. An adequate ventilation device should be installed where aniline is loaded in drums so as to keep aniline density in the air below the minimum limit.

8.1.2 Wear appropriate respiratory protection, head wear, rubber gloves, rubber apron and gum boot while washing or repairing tanks or other equipment or washing any other place after a large amount of aniline has leaked, or when pipes or equipment are damaged.

8.1.3 In case of entering into a tank or any perfectly closed facility, repeat washing with steam and water. It is recommended to measure, before entry, the concentration of aniline and confirm that it is below the minimum limit.

8.1.4 Add hydrochloric acid or acetic acid into the equipment according to the material quality of tanks and facilities to neutralize and eliminate aniline completely.

8.1.5 While working in a tank or any perfectly closed facility, put on a gas mask and a rope for relief. A supervisor shall watch carefully the operation from outside.

8.1.6 In case of a lower density or a comparatively short-time operation, a gas mask having an absorption canister for organic gas may be used. In this case oxygen in the air shall be more than 16 percent in terms of volume.

8.1.7 In case the concentration of aniline vapour is unknown or more than 50 ppm, or the amount of oxygen is less than 16 percent, an airline respirator or self-contained breathing apparatus shall be used.

8.1.8 Use protective cream, protective gloves, protective spectacles and protective shoes in case it is feared that aniline may come in contact with the skin.

8.1.8.1 Wash hands and face before meal and after work.

8.1.8.2 Do not try alcoholic drinks while you may be exposed to aniline.

8.1.9 Administer sodium thiosulphate, vitamin C, cystine, glutathione, adrenal cortical preparations, folic acid, vitamin B_{12}, dextrose or methionine for the antipoison purpose, pursuant to doctor's instructions.

8.1.10 *Pre-employment Medical Examination* — For handling aniline, it is unsuitable to employ a person having heart and kidney trouble, a syphilitic patient, a person suffering from any urinary disease, especially a calculus person, or having some troubles in the circulation system, a person of allergy or a heavy drinker. Carry out a blood test before employment.

8.1.11 *Regular Health Examination* — Besides the regular health examination, which is carried out more than twice every year, conduct blood tests every month on the following examination standards in order to check the conditions of workers who may be exposed to aniline and confirm no anaemia case:

EXAMINATION STANDARDS OF BLOOD TESTS

State	*Relative Density of Total Blood*	*The Number of Red Blood Cells*	*The Amount of Hemoglobin (g/dl)*	*Remarks*
Normal	More than 1·055	More than 500 000	More than 13·0	Avoid strictly any possessor of parasite eggs and such secondary patients as suffer from tuberculosis, syphilis, etc.
Careful observation necessary	More than 1·052	More than 4 000 000	More than 12·0	
Rest required	Less than 1·052	Less than 4 000 000	Less than 12·0	

Urine tests (urobilinogen, porphyrin, occult blood test, deposit) should be conducted once every two weeks, especially once a week in summer. It is desirable to carry out the close examination including cystoscopy to a person who is positive in occult blood test.

8.2 Personnel Protection

8.2.1 *Employee Education and Training* — Safety in handling aniline depends, to a great extent, upon the effectiveness of employees' education, proper safety instructions, intelligent supervision and the use of safe equipment.

8.2.1.1 The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is the responsibility of supervision. Training classes for both new and old employees should be conducted periodically to maintain a high degree of safety in handling procedures. Workers shall be thoroughly informed of the hazards that may result from improper handling of aniline. They should be cautioned to prevent spills and thoroughly instructed regarding proper action to take in case they occur. Each employee should know what to do in any emergency and shall be fully informed as to first-aid measures.

8.2.1.2 In addition to the above, employee education and training shall include the following:

a) Instructions and periodic drill or quiz regarding the location, purpose and use of personal protective equipment.

b) Instructions and periodic drill or quiz regarding the location of safety showers, eye baths, bubbler drinking fountains, or the closest source of water for use in emergencies.

c) Instructions to avoid all inhalation of vapours of aniline and all direct contact with the liquid.

d) Instructions to report to the proper authority all signs of illness.

e) Instructions to report to the proper authority all cases of equipment failure.

f) Workers should be warned that the ingestion of even small amounts of alcoholic beverages preceding or following absorption of aniline will markedly increase its toxic effects. Habitual users of alcohol shall not be permitted to work in an area in which potential exposures to this compound exist.

8.2.2 *Personal Protective Equipment*

8.2.2.1 *Availability and use* — While personal protective equipment is not an adequate substitute for good safe working conditions, adequate ventilation, and intelligent conduct on the part of employees working with aniline, it is, in many instances, the only practical means of protecting the worker, particularly in emergency situations. One should keep firmly in mind that personal protective equipment protects only the worker wearing it and other unprotected workers in the area may be exposed to danger.

The correct usage of personal protective equipment requires the education of the worker in proper employment of the equipment available to him. Under conditions which are sufficiently hazardous to require personal protective equipment, its use should be supervised and the type of protective equipment selected shall be capable of control over any potential hazards.

The following personal protective equipment shall be used when indicated.

8.2.2.2 *Eye protection*

a) *Chemical safety goggles* — Cup type of rubber framed goggles, equipped with the approved impact resistant glass or plastic lenses, should be worn whenever there is danger of aniline coming in contact with the eyes. Goggles should be carefully fitted.

b) *Spectacle-type safety goggles* — Metal or plastic rim safety spectacles with unperforated side shields which can be obtained with prescription safety lenses or suitable all-plastic safety goggles may be used where continuous eye protection is desirable, as in laboratories. These types, however, should not be used where complete eye protection against aniline is needed.

c) *Face shields* — Plastic shields (full length, *20 cm minimum*) with forehead protection may be worn in addition to chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of material striking the eyes from underneath or around the sides of the face shield.

8.2.2.3 *Respiratory protection* — Severe exposure to aniline may occur in tanks during equipment cleaning and repairs, when decontaminating areas following spills, or in case of failure of piping or equipment (*see* Note). Employees who may be subject to such exposures should be provided and trained with proper respiratory protection in its use and care. Available types are described below:

a) *Self-contained breathing apparatus* — Which permits the wearer to carry a supply of oxygen or air compressed in the cylinder and the self-generating type which produces oxygen chemically, allow considerable mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen or regenerating material it carries. Compressed oxygen should not be used where there is danger of contact with flammable liquids, vapours, or sources of ignition, especially in confined spaces such as tanks or pits.

b) *Positive pressure hose masks* — Supplied by blowers requiring no internal lubrication. The wearer shall be able to use the same route for exit as for entrances and shall take precautions to keep the hose line free of entanglement. The air blower shall be placed in area free of contaminants.

c) *Air line masks* — Supplied with clean compressed air, suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air piped to the area from a compressor. It is extremely important that the air supply is taken from a safe source, and that it is not contaminated by oil, mist, grit and carbon monoxide from inadequate cooling at the compressor. The safer method is to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valve as well as suitable traps and filters shall be installed at all mask stations. An alternate arrangement frequently used for high pressure breathing air from standard cylinders is with a demand-type valve and face piece. This arrangement may also be used with cleaned, piped, fresh air, and, as an additional precaution with the demand mask, a small cylinder of compressed air may be worn for use as an emergency escape from the area.

d) *Industrial canister type gas masks* — Equipped with full face piece and approved, fitted with the proper canister (organic vapour) for absorbing aniline vapour. These will afford protection against concentration not exceeding 2 percent by volume when used in accordance with manufacturer's instructions. The oxygen content of the air shall not be less than 16 percent by volume. The mask should be used for relatively short exposure periods only. They may not be suitable for use in an emergency since, at the time, the actual vapour concentration is unknown and an oxygen deficiency may exist. The wearer shall be warned to leave the contaminated area immediately on detecting the odour of a harmful vapour. This may indicate that the mask is not functioning properly, that the vapour concentration is too high, that the canister is exhausted or that the mask is not properly fitted.

Caution: Filter type respirators do not offer protection against gases and are unsuitable for use when working with aniline.

NOTE — Respiratory protective equipment shall be carefully maintained, inspected, cleaned and sterilized at regular intervals and always before and after use by another person.

8.2.2.4 *Head protection* — 'Hard' hats should be worn where there is danger from falling objects. If hard hats are not considered necessary, soft brimmed hats or caps may be worn to give protection against liquid leaks and splashes.

8.2.2.5 *Foot protection* — Rubber safety shoes with built-in steel toe caps are recommended for workers handling drums and cans of aniline. Rubbers should be worn over leather safety shoes where there is danger of spills. Rubbers and shoes shall be thoroughly cleaned and ventilated after contamination.

8.2.2.6 *Body, skin and hand protection* — It is imperative that contaminated clothing be removed promptly and laundered before re-use. Affected areas of the body shall be washed thoroughly with water. As a general hygienic measure, facilities for personal cleanliness should be provided and washing before lunch and at the end of the work day should be encouraged. Clothing made of rubber or other impervious material may be worn to protect the body against aniline splashes. These garments shall be cleaned inside and outside each time they are used.

9. MEDICAL MANAGEMENT

9.1 Health Hazards — Aniline is highly toxic but may be handled safely if proper precautions are observed. Toxic levels may be reached in the blood and tissues by absorption of the liquid through the intact skin, inhalation of vapours or ingestion of the liquid. The most common modes of accidental poisoning are spillage of the liquid on the skin or clothing leading to direct skin contact or the prolonged inhalation of vapour under circumstances of inadequate ventilation.

9.2 Preventive Health Measures

9.2.1 *Environmental Control* — Aniline is not a serious industrial hazard if workers are adequately instructed and supervised in proper means of handling the chemical. Wherever possible, aniline should be handled within a wholly closed system. Contact with the skin and eyes, as well as the inhalation of vapours, shall be avoided. Emergency showers and eye fountains shall be provided in areas where a potential exposure to aniline exists.

9.2.2 *Threshold Limit Value* — A value of 5 ppm by volume in air has been suggested as the maximum allowable concentration considered safe for an 8-hour working exposure.

9.2.3 *Personal Hygiene and Employee Education* — Food shall never be stored nor eaten near aniline nor be in the proximity of aniline handling operations. Clothing that has become contaminated with aniline should be promptly removed and thoroughly laundered. Contaminated shoes shall be discarded and replaced. Employees shall take a shower and wash thoroughly with soap at the end of each work day and immediately after accidental bodily contact due to spillage.

9.2.4 *Physical Examination*

9.2.4.1 *Preplacement examination* — Candidates with anaemia or those addicted to alcohol should not be assigned to jobs involving possible exposure to aniline.

9.2.4.2 *Periodic health examination* — The usual periodic examination normally given by the plant physician in checking general physical condition of workers is all that is required.

9.3 Suggestions to Physicians

9.3.1 If possible while the patient is acutely ill, methemoglobin concentrations of the blood should be determined quantitatively at frequent intervals. Such determinations shall be continued until it is definitely established that the concentration of methemoglobin is steadily decreasing. Methemoglobin may be quantitatively determined by several methods. An intravenous injection of 10 to 20 ml of sodium thiosulphate and a large dose of vitamin C at one time, will contribute to quick recovery. If the concentration of methemoglobin reaches 40 percent in a venous blood sample, 1 000 ml of 5 percent glucose may be administered intravenously.

9.3.2 Oxygen (tent, mask or nasal catheter) serves to relieve headache transiently, apparently due to saturation of the hemoglobin and plasma with oxygen, but does not seem to accelerate the reversion of methemoglobin to hemoglobin.

9.3.3 Under such treatment, acutely toxic patients with methemoglobin concentrations as high as 70 percent in venous blood samples usually make uneventful recoveries within 24 hours, with no demonstrable permanent, residual effect. When methemoglobin levels reach 60 percent or more 10 ml of a 1-percent solution of methylene blue (dose 1 to 2 mg/kg body mass) may be given intravenously over a period of five minutes. This is reported to hasten recovery.

9.3.4 It is imperative that patients be closely observed and remain in bed for 24 hours if the methemoglobin content has reached 40 percent. In the rare instances, in which a state of collapse intervenes, respiratory and cardiac stimulants may be administered at the discretion of the attending physician.

10. FIRST-AID

10.1 General Procedures

10.1.1 Contaminated clothing should be removed at once. Speed in removing aniline from the skin is of prime importance. A thorough shower, taken immediately, with plenty of soap and lukewarm water is imperative. The patient should then be transported on stretcher without delay to the medical department or first-aid station for observation and care. Call a physician at once.

10.1.2 After making sure that all aniline has been removed from body surfaces the patient should be put to bed and kept warm in a well ventilated room. Bed rest is imperative. If the patient becomes increasingly cyanotic before the arrival of a physician, oxygen may be administered by first-aid personnel who have been thoroughly instructed in this technique. Patients, while conscious, may be given fluids by mouth, preferably those containing sugar, such as orange juice, grapefruit juice, sweetened lemonade or strong black coffee.

10.1.3 Alcohol in any form should never be administered to anyone with aniline poisoning. Aspirin or codeine may be used to relieve severe headache but drugs such as acetanilide, acetphenetidine and other methemoglobin formers should not be used. Inhalation of oxygen will transiently relieve headache.

10.1.4 In a serious case, practise artificial respiration, oxygen inhalation, blood letting and transfusion. Give a collapsed patient stimulants for respiration and circulation of blood, such as sodium benzoate and caffeine in order to heat the body, lest the temperature of the body should decline.

10.2 Contact with Skin and Mucous Membranes — Remove all contaminated clothing. Wash the affected areas immediately and thoroughly with plenty of water, using warm water and soap if available. It is, however, only 3 or 4 percent soluble in water and even more insoluble in soap, but can be readily sponged off with vinegar, lemon juice or any acid, dilute enough not to produce skin burns. In case of an accident, however, one should not wait to get acid to remove the aniline but should immediately take off the clothing and get under an emergency shower. The running water will mechanically remove some of the aniline, at least the gross contamination, and the traces can be removed with dilute acids or alcohol when they become available. The clothes may be washed with dilute hydrochloric acid or acetic acid and then with water. Contaminated clothing shall be thoroughly laundered before again being worn.

10.3 Contact with Eyes — Following any aniline splash in the eyes, there should be copious flushing with water to be continued for at least 10 minutes. If necessary, the lids should be held apart to permit thorough irrigation. Aniline is mildly irritating to the eyes and corneal damage may occur. Therefore, all such cases should be seen by a physician as soon as possible.

10.4 Ingestion

10.4.1 Accidental or suicidal ingestion of aniline should be treated by the prompt administration of an emetic, such as mustard and water, or the lukewarm emulsion of soap and water, provided the patient is conscious.

10.4.2 Never give anything by mouth to an unconscious person.

10.4.3 Gastic lavage should be instituted promptly by someone who is adequately trained.

10.5 Inhalation — Inhalation of the vapour of aniline gives the same clinical picture as absorption through the skin or by ingestion, and requires the same treatment.

11. FIRE FIGHTING

11.1 Fires involving aniline can be extinguished with water when applied in the form of fog or spray. Carbon dioxide, dry chemical and 'alcohol' type foam extinguishers are also effective on small fires.

11.2 At any place where large quantity of aniline is used or stored, install hydrants, fire pumps, water jets or air foam facilities besides the above mentioned extinguishers.

11.3 While fighting fire involving aniline, firemen should be equipped with standard firemen's clothing plus adequate eye protection. If fire fighting involves work in closed or confined quarters, the firemen shall be equipped with proper respiratory protection.

11.4 If the fire gains headway, it would become extremely difficult to fight against the fire because of too fierce flames and toxic gas. The effective method to fight against fire is to enclose the entire fire area with water jet to cool down the area with its latent heat and shut out air with the mass of steam generated around the area.

12. CLEANING AND REPAIRING OF TANKS AND EQUIPMENT

12.1 Preparation of Tanks and Equipment

12.1.1 Tank and equipment cleaning should be under the direction of thoroughly trained personnel who are fully familiar with all the hazards and the safeguards necessary for the safe performance of their work. The main hazards are exposure to aniline liquid and to toxic fumes.

12.1.2 Tanks and equipment, pumps, lines and valves should always be drained and thoroughly flushed with water before being repaired. Workmen should never be allowed to attempt to repair equipment while it is in operation and the lines full. If pipe sections are to be removed and flanges opened, the lower bolts shall be loosened first and although the lines have been flushed, care shall be taken to avoid personal contact with the liquid draining, or dripping from the equipment. All spillage from the lines or equipment shall be removed immediately by flushing to the drain with large quantities of water.

12.1.3 The tank or equipment to be repaired shall first be emptied of all liquid, and all pipes leading to and from the tank (except vents) after draining shall be disconnected or blanked off.

12.1.4 The tank should be steamed to remove residual aniline and vapours.

12.1.5 The tank should be cooled, preferably by filling with water and draining once or twice.

12.1.6 The tank should then be purged with fresh air and the atmosphere shall be tested for aniline vapours and oxygen deficiency.

12.2 Entering Tank

12.2.1 No one should enter a tank or confined space until work permit has been signed by an authorized person indicating that the area has been tested and found to be safe. Furthermore, no workman shall enter a tank or vessel that does not have a manhole opening large enough to admit a person wearing a safety harness, life line, and emergency respiratory equipment. It shall be ascertained that the tank or vessel can be left by the original entrance.

12.2.2 When a man enters the tank, one man on the outside of the tank shall keep the man in the tank under observation and another man should be available nearby to aid in case of any risk to the man in the tank.

12.2.3 A supplied-air respirator (hose mask) or self-contained breathing apparatus, together with harness and life line shall always be located outside the tank entrance for rescue purposes, regardless of the type of respiratory equipment or air supply which is provided for employees inside the tank. A 'chem-suit' of material impervious to aniline shall be worn.

12.2.4 Special ventilation is recommended during the entire time men are cleaning, repairing, or inspecting the tank. Ventilation can be accomplished by exhausting or removing vapours from the bottom of the tank either through its bottom openings, or by exhausting the vapours from the tank bottom by means of a large flexible duct where tanks have a top opening only.

12.2.5 On tanks having only a top opening, care shall be exercised to ensure complete removal of vapours from the entire tank. Care shall also be taken to avoid having exhaust gases recycled into the tank.

12.2.6 During the course of the work, frequent tests should be made to determine that the atmosphere in the tank is being maintained within the safe range. This precaution is necessary because residues not completely removed by washing may recontaminate the tank atmosphere.

12.2.7 In all cases, if repair work is interrupted, the tank atmosphere should be checked thoroughly and a new work permit issued before resumption of work.

12.3 Emergency Rescue — Under no circumstances shall a rescuer enter a tank to remove a victim of overexposure without proper respiratory protection, a safety harness and an attached life line. The free end of the life line shall be manned by an attendant located outside the tank. Another attendant should be immediately available to assist in the rescue, if needed. The rescuer should be in view of the outside attendant at all times or in constant communication with him.

12.4 Exterior Repair Work

12.4.1 Exterior tank repairs, including repairs to steam coils, cutting, riveting and welding, should be permitted only after thorough cleaning and testing of the tank to make sure it is free of vapours and after work permit has been issued by an authorized person.

12.4.2 All outside welding or burning on tanks or equipment which have contained aniline should be done only after such containers have been completely purged with steam. Purging should be continued while the repair work is in progress. Filling empty tanks with inert gas is another method which may be used in outside welding or burning.

12.4.3 In all cases, if repair work is interrupted, the tank atmosphere should be checked thoroughly and a new work permit issued before resumption of work.

13. DISPOSAL OF WASTE

13.1 All local and state regulations concerning waste disposal to streams, municipal treatment plants, or into the ground should be determined and complied with.

13.2 In the interest of economy and avoidance of possible polluting discharge, aniline can be recovered by extraction with water-immiscible solvents or by steam distillation.

13.3 Aniline is soluble in water and is biologically degradable. As it has a high biochemical oxygen demand, precautions should be taken to avoid shock loadings on treatment plants using biological processes. The maximum allowable concentration in potable water supplies has been given as 5 ppm.

13.4 If residues containing aniline are to be disposed of in impounding basins or otherwise discharged to the ground, necessary precautions shall be taken to prevent ground water contamination. Care shall also be taken to keep unprotected workers and the general public away from such disposal areas.

13.5 Small quantities of aniline may be safely sewered, if diluted with copious quantities of water, preferably to a concentration of less than 0·5 percent. No separable phase shall persist.

(*Continued from page* 2)

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INDIAN STANDARDS
ON
CHEMICAL AND ALLIED HAZARDS

IS:

1260-1958 Code of symbols for labelling of dangerous goods
1446-1959 Classification of dangerous goods
1913-1961 General and safety requirements for electric light fittings
2551-1963 Danger notice plates
2553-1964 Safety glass (*revised*)
2925-1964 Industrial safety helmets
4155-1966 Glossary of terms relating to chemical and radiation hazards and hazardous chemicals
4209-1966 Code of safety for chemical laboratories
4262-1967 Code of safety for sulphuric acid
4263-1967 Code of safety for chlorine
4264-1967 Code of safety for caustic soda
4312-1967 Code of safety for lead and its compounds
4544-1968 Code of safety for ammonia
4560-1968 Code of safety for nitric acid
4607-1968 Classification of hazardous chemicals and chemical products
4644-1968 Code of safety for benzene, toluene and xylene
4906-1968 Code of safety for radiochemical laboratory
5184-1969 Code of safety for hydrofluoric acid
5208-1969 Code of safety for acetic acid
5302-1969 Code of safety for acetic anhydride
5311-1969 Code of safety for carbon tetrachloride
5685-1970 Code of safety for carbon disulphite (carbon bisulphide)
6156-1971 Code of safety for chlorosulphonic acid
6164-1971 Code of safety for hydrochloric acid
6269-1971 Code of safety for ethylene oxide
6270-1971 Code of safety for phenol
6818-1973 Code of safety for phosphoric acid
6819-1973 Code of safety for calcium carbide
6953-1973 Code of safety for bromine
6954-1973 Code of safety for caustic potash
7415-1974 Code of safety for aniline
7420-1974 Code of safety for phthalic anhydride

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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Printed at Simco Printing Press, Delhi, India